Epicardial stenosis severity does not affect minimal microcirculatory resistance

Epicardial Stenosis Severity Does Not Affect Minimal Microcirculatory Resistance

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Background

Recently, we introduced an invasive index of microcirculatory resistance (IMR) calculated by the product of distal coronary pressure (P_d) and thermodilution-derived mean transit time (T_{mn}) measured at hyperemia: $IMR = P_d \cdot T_{mn}$.

In the absence of epicardial stenosis, myocardial flow is equal to coronary flow, and IMR correlates well with true myocardial resistance. In the presence of a stenosis however, myocardial flow is not only determined by coronary flow but also by collateral flow. In such a case, IMR (and comparable indices of microvascular resistance) can be calculated reliably by incorporating wedge pressure (P_w):

$$IMR = P_a \cdot T_{mn} \frac{P_d - P_w}{P_a - P_w}$$

The aims of this study were to investigate the feasibility of determining IMR in humans and to test the hypothesis that microcirculatory resistance is independent of the presence of a stenosis.

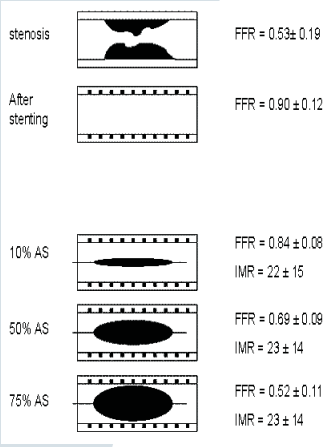

Figure 1: Schematic representation of the different steps of the protocol and corresponding values of FFR and IMR. AS, area stenosis; FFR, fractional flow reserve; IMR, index of microvascular resistance.

Methods

30 patients referred for stenting of a coronary artery stenosis were studied. Using a pressure/temperature guidewire, the lesion was stented and during balloon occlusion, coronary wedge pressure was measured. After stenting, a short balloon with a diameter of 1.0 mm smaller than the deployed stent was introduced into the stented segment and inflated with increasing pressures, creating 3 stenoses with increasing severity of 10%, 50% and 75%, respectively.

At each degree of stenosis, fractional flow reserve (FFR) and IMR were measured, using intravenous adenosine for steady state hyperemia.

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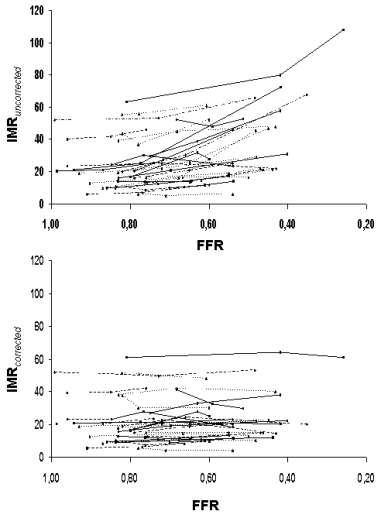

Figure 2: Relation between microvascular resistance and epicardial stenosis severity without correcting for collateral flow (upper panel) and with correction for collateral flow (lower panel).

Results

90 measurements of IMR were done in 30 patients. When IMR was not corrected for P_w, an apparent increase in microvascular resistance was observed with increasing stenosis severity (IMR = 24, 27 and 37 U for the 3 different degrees of stenosis, $p < 0.001$). In contrast, when taking into account collateral flow by incorporating P_w as indicated above, IMR did not change with stenosis severity (IMR = 22, 23 and 23 U respectively, $p = 0.28$).

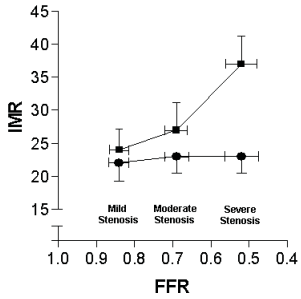

Figure 3: The relationship between microvascular resistance (IMR) and stenosis severity (expressed by FFR) when collateral flow is taken into account (dots) and when collateral flow is neglected (squares).

Conclusion

(1) Guidewire-based assessment of microvascular resistance by IMR is feasible in humans during PCI.

(2) Minimal microvascular resistance, if calculated appropriately, is independent of epicardial stenosis severity.